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STRIKING CIRCUIT FOR A HIGH-PRESSURE GAS DISCHARGE LAMP

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(57) Claim

1. Ignition circuit for a high pressure gas discharge lamp connectable via corresponding input terminals to an ac voltage source,

having a pulse transformer the secondary winding of which is arranged between one of the input terminals and the lamp having a pulse capacitor connected in parallel with the secondary winding and the lamp having a series circuit of a primary winding of the pulse transformer and a switch element connected in parallel to the pulse capacitor, and having a controllable switch connected in series with the parallel circuit of the pulse capacitor on the one had and the primary winding and the switch element on the other hand, wherein the controllable switch is - when an ignition pulse for the lamp is present - temporarily switched for a certain time interval into a first condition in which the parallel circuit is separated from the ac voltage source.

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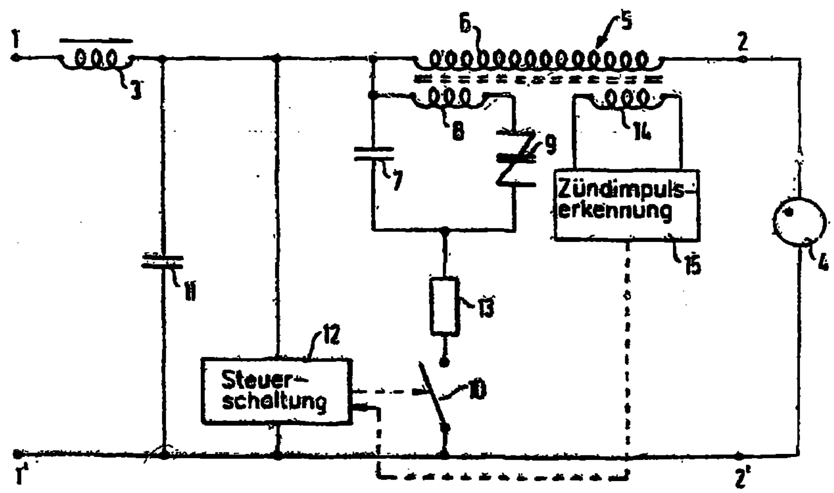
(54) **Title:** STRIKING CIRCUIT FOR A HIGH-PRESSURE GAS DISCHARGE LAMP

(54) **Bezeichnung:** ZÜNDSCHALTUNG FÜR EINE HOCHDRUCK-GASENTLADUNGSLAMPE

(57) **Abstract**

A striking circuit for a high-pressure discharge lamp (4) connected via a choke (3) to an a.c. voltage source and with a pulse transformer (5), the secondary winding (6) of which is fitted between the choke (3) and the lamp (4) and the primary winding (8) of which, with a switching component (9), forms a series circuit which in turn is connected in parallel to a pulse capacitor, in which a controllable switch (10) is connected in series with the parallel circuit of the pulse capacitor (7) on the one hand and the primary winding (8) and the switching component (9) on the other, said switch (10) being actuated on the occurrence of a striking pulse for the high-pressure gas discharge lamp (4) in such a way that the settlement of the oscillating circuit consisting of the pulse capacitor (7), the primary winding (8) and the switching component (9) or the rapid recovery of the switching component (9) is ensured. It is thus possible to obtain a short striking pulse sequence with a large number of striking pulses, thus ensuring that the lamp is reliably struck.



12...CONTROL CIRCUIT
15...STRIKING PULSE RECOGNITION

Ignition circuit for a high pressure gas discharge lamp

The invention relates to an ignition circuit for a high pressure gas discharge lamp.

Such an ignition circuit is known for example from DE 31 08 547 C2 and DE 31 08 548 C2.

Figure 10 shows a schematic circuit diagram of this ignition circuit. The high pressure gas discharge lamp or high pressure metal vapour discharge lamp 4 (also referred to as "lamp" below) is connected to the output terminals 2 and 2' of the ignition circuit. The ignition circuit has a pulse transformer 5 the secondary winding 6 of which is connected in the voltage-carrying supply line between the lamp 4 and a conventional magnetic ballast 3, e.g. a choke. A series circuit of a pulse capacitor 7 and an auxiliary ignition capacitor 11 is connected in parallel with the series circuit of the secondary winding 6 of the pulse transformer 5 and the lamp 4, a series circuit of the primary winding 8 of the pulse transformer 5 and a symmetrically switching switch element 9 being connected in parallel with the pulse capacitor 7. The symmetrically switching switch element 9 may be for example a pnpn device, a triac or a sidac. Likewise, the employment of a gas spark gap is conceivable. By way of example, in Figure 10 the symmetrically switching switch element 9 is represented as a sidac. A charging resistance 13 is connected in parallel with the auxiliary ignition capacitor 11.

The function of the circuit illustrated in Figure 10 is as follows:

The pulse capacitor 7 is charged via the parallel connection of the auxiliary ignition capacitor 11 and the

charging resistance 13 until its voltage exceeds the switching voltage of the sidac 9, so that the sidac breaks down and assumes a low resistance condition. With the breakdown of the sidac, the pulse capacitor 7 is short-circuited via the primary winding 8 of the pulse transformer 5 and discharges via the primary winding 8. The voltage drop in the primary winding 8 is upwardly transformed in the ratio of the winding numbers of the pulse transformer 5, so that an ignition pulse of about 4kV is produced at the lamp 4. Whilst the sidac 9 is still switched to be conductive, the series resonance circuit of the choke 3 and the auxiliary ignition capacitor 11 is excited to oscillate with its natural frequency (about 500 to 2000 Hz), so that there arises at the auxiliary ignition capacitor 11 and across the secondary winding 6 of the pulse transformer a boosted open circuit voltage. After the pulse capacitor 7 has discharged and its voltage has sunk again below the switching voltage of the sidac 9, the sidac takes up a blocking state with reversal of the current and interrupts the current path for the series resonance circuit of the choke 3 and the auxiliary ignition capacitor 11. During this, the pulse capacitor 7 again attains, in the course of the oscillation, the switching voltage of the sidac 9 and switches the sidac to conduct once more. This process occurs repeatedly in the course of a mains half-wave. Through the close series of the ignition pulses at boosted supply voltage, the ignition is ensured even of lamps which are difficult to ignite.

The ignition circuit must, in accordance with the requirements of lamp manufacturers, be so formed that at least three ignition pulses are generated per mains half-wave with a maximum pulse spacing of 0.3 ms. Further, the circuit is to be so configured that for a reliable lamp ignition a phase disposition of the ignition pulses is ensured which is between 60°el and 90°el of the increasing magnitude, positive or negative, mains half-waves.

EP 0 381 083 A1 and EP 0 314 178 A1. of the present applicant, describe similar ignition circuits for high pressure gas discharge lamps.

With the above-described circuit, however, the ignition of lamps of lesser power, for example 35 W, is problematic. In this case, the required ignition pulse spacing cannot be maintained or can be maintained only with difficulty. this has its cause in that for lesser lamp powers a higher impedance for the choke 3 is required and the increased impedance of the choke 3 in combination with the pulse capacitor 7 and the auxiliary ignition capacitor 11 brings about a lower series resonance frequency, so that the spacing between the ignition pulses is increased. To counter this effect it has already been proposed, in EP 0 314 178 A1 of the present applicant, to employ merely a part of the choke 3 for the ignition and after the ignition of the lamp to switch in the second part of the choke, so that the series resonance frequency and the temporal pulse spacing is determine only by the first part of the choke, whilst the current flowing through the lamp is limited after ignition of the lamp, by the series-connected choke parts. In this way there can be ensured on the one hand a sufficiently high series resonance frequency with the required low ignition pulse spacing, and on the other hand a sufficiently great lamp current limitation. For the circuitry construction proposed in this document there is necessary, however, a choke with taps - whereby the overall ignition circuit or the choke arrangement is made more expensive.

Further, with the known ignition circuit it has proved to be difficult to exploit the phase range from 60°el - 90°el of the positive mains half-wave or from 240°el - 270°el of the negative half-wave for giving rise to the ignition impulses over the whole range in which the mains voltage may vary, ie between 198V and 264V. In the outer limits of this mains voltage variation range, the phase regions are not, as a rule, maintained as required. This is made even more difficult when the mains voltage frequency is not only 50Hz, but - as for example in the USA - 60Hz.

Further, with the known circuits, for achieving a pulse series which is as short as possible, the employment of high quality sidac types is unavoidable, whereby the price of the ignition circuit is, however, increased. In order to achieve a greatest possible number of ignition pulses it is necessary that the charge time of the pulse capacitor 7 and

the recovery time of the switch element 9 are maintained as short as possible. In the known and above-described circuits, a short recovery time is, however, possible only to a limited degree, since a current of the a.c. voltage supply is continuously supplied via the auxiliary ignition capacitor 11 and the load resistance 13 (c.f. Figure 10) to the ignition current path having the pulse capacitor 7 and the switch element 9 and the primary winding 8 of the pulse transformer 5. The generation of a high number of ignition pulses is thus set limits in the known circuits. This is true in particular when the ignition circuit is intended to be employed for igniting lamps of lower power.

From DE-A1-43 33 884 there is known an ignition circuit according to the preamble of claim 1. In accordance with this publication there is proposed as controllable switch a bipolar transistor, which is connected in series with the parallel circuit of the pulse capacitor on the one hand and on the other hand the primary winding of the transformer and, as switching element, a switch spark path. However, in combination with other components, the bipolar transistor forms a constant current source in order - after an extinguishing of a high-pressure gas discharge lamp - to attain a re-ignition of the lamp which is as rapid as possible, since the charge voltage of the pulse capacitor increases linearly with time via the constant current source.

From EP-A1-0 613 326 there is known a further ignition circuit for a high-pressure gas discharge lamp, whereby a sidac acting as a switch element is connected parallel to a series circuit of a part of the secondary winding of a transformer and a pulse capacitor. A controllable switch is connected in series with this parallel circuit. Upon switching on of the mains voltage, this controllable switch remains switched on until a timer circuit has detected the expiry of a particular period of time. After expiry of

this period of time the controllable switch is opened in order to avoid further ignitions of the lamp with the aid of the ignition circuit including the sidac and the pulse capacitor. The timer circuit is reset when the partial mains voltage supplied thereto has fallen below a predetermined minimum value, at which the lamp is extinguished, so that in this case the controllable switch is again switched on and the ignition circuit is activated anew.

The object of the invention is thus to avoid the above-described disadvantages or to provide an alternative.

The present invention accordingly provides an ignition circuit for a high pressure gas discharge lamp connectable via corresponding input terminals to an ac voltage source, having a pulse transformer the secondary winding of which is arranged between one of the input terminals and the lamp having a pulse capacitor connected in parallel with the secondary winding and the lamp having a series circuit of a primary winding of the pulse transformer and a switch element connected in parallel to the pulse capacitor, and having a controllable switch connected in series with the parallel circuit of the pulse capacitor on the one hand and the primary winding and the switch element on the other hand, wherein the controllable switch is - when an ignition pulse for the lamp is present - temporarily switched for a certain time interval into a first condition in which the parallel circuit is separated from the ac voltage source.

The controllable switch may be formed as a single pole switch which is switched off, i.e. opened, for a predetermined time, directly after breakdown of the switch element in the ignition circuit, so that the current in the oscillation circuit - of the pulse capacitor, the switch element and the primary winding of the pulse transformer - can reliably and quickly decay. Equally, the controlled switch can be provided as a double pole switch i.e. as change-over switch, whereby in one position the parallel circuit of pulse capacitor, primary winding and switch element is connected with the a.c. voltage source as known, and after the breakdown of the switch element, the parallel circuit is short-circuited and/or separated from the a.c. voltage source in the second position in order to discharge the pulse capacitor temporally more rapidly. Thus it is ensured that the controllable switch can block rapidly and reliably which makes possible short ignition pulse spacing.

The function of the ignition circuit in accordance with the invention is as follows:

The controllable switch is initially in that condition which separates the parallel circuit of pulse capacitor, primary winding and switch element from the a.c. voltage source. In the case of a single pole switch, this means that the switch is open. If the a.c. voltage delivered from the a.c. voltage source is in the required phase range 60°el - 90°el of the increasing magnitude, positive or negative, half-wave, i.e. between 60°el - 90°el of the increasing positive or between 240°el - 270°el of the increasing negative mains half-wave, the controllable switch is thus switched into a second condition in which

the above-mentioned parallel circuit is connected with the a.c. voltage source, so that the pulse capacitor of the parallel circuit can charge up through the energy supplied from the a.c. voltage source. In the case of a single pole switch, this means that the controllable switch is closed. As soon as an ignition pulse for the lamp is present, i.e. as soon as the switch element breaks down and short-circuits the pulse capacitor, the controllable switch is again switched into the original first condition, and moreover preferably for so long as is required by the recovery time of the switch element, e.g. 80μs. After expiry of this predetermined time interval, the switch is then again switched into the second condition, so that a new ignition pulse can be generated.

Short circuit protection, for example PTC resistance, can be connected in series with the charge capacitor, in order to avoid a thermal overloading of the ignition circuit upon short-circuiting of any one of the switch elements.

For controlling the controllable switch there is preferably employed a control circuit which may be formed in particular as a customer-specific integrated circuit, i.e. as a so-called ASIC. For temporal control of the controllable switch, the ASIC may include a counter. Further, for detection of an ignition pulse, the ASIC may have an ignition pulse recognition device. Particularly advantageous is the presence of a lamp ignition recognition device in the ASIC, so that not only the appearance of an ignition pulse can be detected, but also the condition when the lamp itself is conductive, i.e. when a gas discharge path has formed in the lamp. If the ignition of the lamp is recognized, the controllable switch, which may be for example a bipolar transistor, a field effect transistor or a simple relay, can thus by means of the control circuit (ASIC) be held permanently in the first or second condition; in the case of a single pole switch thus held

permanently opened or closed.

The subclaims describe advantageous further developments of the present invention.

Below, the invention will be described in more detail with reference to preferred exemplary embodiments and with reference to the drawings, which show:

Figure 1a and 1b	a first exemplary embodiment of the ignition circuit in accordance with the invention in a schematic representation and a more detailed view,
Figure 2	a second exemplary embodiment in accordance with the invention,
Figure 3	a third exemplary embodiment in accordance with the invention,
Figure 4	a more detailed view of the control circuit in accordance with the present invention,
Figure 5 - Figure 7	characteristics as a function of time with ignition pulse generation using the ignition circuit in accordance with the present invention,
Figures 8 and 9	exemplary characteristics as a function of time for the ignition pulse control in accordance with the invention by means of the intelligent timer of Figure 4 in accordance with the invention, and

Figure 10 a known ignition circuit.

Figure 1a shows a first exemplary embodiment of the ignition circuit in accordance with the invention.

As does the known ignition circuit shown in Figure 10, the ignition circuit shown in Figure 1a also has a choke 3 serving as magnetic ballast, a pulse transformer 5 the secondary winding 6 of which is connected in series with the choke 3 and the high pressure gas discharge lamp 4 and the primary winding 8 of which is connected in series with a switch element 9, and a pulse capacitor 7, whereby the pulse capacitor 7 on the one hand and the series connection of the primary winding 8 and the switch element 9 on the other hand form a parallel circuit which for its part is connected in series with a charging resistance 13 and a controllable switch 10. Even though in Figure 1 the symmetrically switching switch element 9 is illustrated as a sidac - which breaks down above a particular positive switching voltage and below a particular negative voltage, and is highly resistive in the region therebetween - it is however apparent that other correspondingly controlled switch elements can be employed, such as for example a gas spark gap, pnpn device, a controlled triac or a controlled transistor in a rectifier bridge. The controllable switch 10 is preferably a controlled bipolar transistor in a rectifier bridge or a field effect transistor. Further, there is present an auxiliary ignition capacitor 11 and a control circuit 12 which serves for control of the controllable switch 10. The control circuit 12 controls the controllable switch 10 temporally in dependence upon the appearance of an ignition pulse for the high pressure gas discharge lamp 4, whereby an ignition pulse is detected by means of a correspondingly present ignition pulse recognition means 15 which is connected with the pulse transformer 5 by means of a special winding 14. An ignition pulse can, however, be determined also at other points of

the circuit.

Figure 1b shows a more detailed view of the ignition circuit in accordance with the invention illustrated in Figure 1a as a schematic circuit diagram. As can be seen from Figure 1b, the controllable switch in accordance with this exemplary embodiment is formed as a single pole switch, which can be switched between an opened and a closed position. A PTC resistance 16 is connected in series with the charging resistance 13, in order to avoid a thermal overloading of the ignition circuit in the case of a short-circuit of the sidac 9 or of the controllable switch 10. If only the low-resistance resistor 13 were present, in the case of a short-circuit of the controllable switch 10 this could be destroyed. This is prevented by means of the PTC resistor 16, since the resistance value of the PTC resistor 16 increases with increasing heating. The control circuit 12 is formed as a customer-specific integrated circuit (in ASIC or PAL), whereby the voltage supply of the control circuit 12 at the inputs V_{cc} and V_{dd} is ensured via an input series resistance 17, a rectifier 21 and an input Zener diode 24 and a supply capacitor 25. The ignition pulse recognition means 15 shown in Figure 1a is, with the circuit shown in Figure 1b, integrated in the control circuit 12. Via a Zener diode 22 and a series resistance 18 the ignition of the lamp is monitored in the control circuit 12, i.e. lamp-alight voltage recognition is carried out. Via the diode 23 and the series resistance 19, the zero-crossing of the mains voltage with each positive mains half-wave is detected in the control circuit 12.

The function of the circuit shown in Figure 1a and 1b is as follows:

Initially the controllable switch 10 is open, so that the parallel circuit of the pulse capacitor 7, the primary winding 8 of the pulse transformer 5 and the sidac 9 is

separated from the a.c. voltage supply present at the terminals 1 and 1'. The control circuit, i.e. the ASIC, preferably contains a counter which is set in operation when a zero-crossing of the mains voltage occurs or the mains voltage as reached a parti-ilar height which corresponds to a particular switching angle. By means of this counting it can be determined when the required switching angle, i.e. the phase disposition between 60°el - 90°el or 240°el - 270°el, is achieved.

When the desired phase disposition is attained, the controllable switch 10 is closed whereby the voltage applied at the auxiliary ignition capacitor 11 is temporarily reduced, since through the closing of the controllable switch 10 the pulse capacitor 7 is connected in parallel with the auxiliary ignition capacitor 11. The secondary winding 6 of the pulse transformer 5 is itself of low resistance. After the closing of the controllable switch 10 there arises the normal ignition behaviour, i.e. the voltage applied at the pulse capacitor 7 increases through charging of the pulse capacitor 7 via the charging resistance 13 and, if applicable, the PTC resistance, so that also the voltage applied at the lamp 4 or the auxiliary ignition capacitor 11 increases. If the switching voltage of the sidac 9 is attained, this short-circuits and the pulse capacitor 7 is discharged via the primary winding 8 of the pulse transformer 5 and the sidac 9, whereby an ignition pulse is generated at the high pressure gas discharge lamp 4 of which the control circuit 12 is informed via the coupled winding 14 and the ignition pulse recognition means 15.

Upon detection of an ignition pulse, the control circuit 12 immediately opens the controllable switch 10 so that the oscillation circuit formed of the pulse capacitor 7, the sidac 9 and the primary winding 8 of the pulse transformer 5 rapidly decays, since no new energy is delivered to this

oscillation circuit. This permits the switch 10 again to be closed anew in a very short time after the opening of the switch 10, so that in accordance with the invention a very short pulse series can be ensured. The time for which the controllable switch 10 is open is selected to be so long that a sufficient recovery of the sidac 9 is ensured. As a rule, for this purpose a time period of 80μs is sufficient. This length of time, i.e. the blocking time of the switch 10, is however dependent upon the type of the switch element 9. Therefore, if appropriate a different blocking time should be set, which may lie in the range 40 - 200μs.

After counting down the 80μs by means of the ASIC, the controllable switch 10 is again closed so that the ignition process can be repeated anew in known manner.

Differently from the form of embodiment shown in Figure 1b, the signal for the ignition pulse recognition means can of course also be taken off at another circuit point. It is thus conceivable to take off the ignition pulse recognition signal from a voltage divider circuit consisting of resistances connected between the rectifier 21 and the control circuit 12, instead of via the components 14 and 20. Further, along with the signal for the zero-crossing recognition there may be supplied also the signal for the lamp-alight voltage recognition via the diode 23 and the resistance circuit 19 of the control circuit 12. In this case, the Zener diode 22 and the resistance circuit 18 can be omitted, so that overall the circuitry configuration is simplified.

Figure 4 shows in a more detailed view the internal configuration of the ASIC 12 illustrated in Figure 1b.

Along with the above-mentioned ignition pulse recognition means 15, the control circuit 12 (ASIC) has the following further functional blocks:

By means of the power-on-reset functional block 28 all functional blocks are reset after each switching on of the ignition circuit. The oscillator 35, via the input terminals e1 or e2 of which one or more external components may be connected for control of the oscillator 35, generates an internal clock signal in the kHz range, with which the internal functional blocks are fed. The lamp-alight voltage recognition means 26 receives at input a a digital signal in the case of a lit lamp, i.e. after successful ignition of the high pressure gas discharge lamp, and directs this - after a set time - to the start counter 33. The zero-crossing recognition means 27 receives with each positive mains half-wave a digital signal at input b, by means of which signal the control circuit 12 is preset and synchronized. The ignition pulse recognition means 15 serves - as explained above - for initiating the so-called blocking time of the controllable switch, which is controlled by means of the blocking time functional block 31. The 50/60 Hz evaluation means 29 serves for recognizing the frequency of the mains voltage and delivers the recognized mains voltage frequency to the pulse phase logic means 30. This pulse phase logic means 30 generates during each mains half-wave, with the aid of the input signals, two windows in the phase range 60°el - 90°el and 240°el - 270°el with a high level, in which the AND logic means 34 is controlled. Directly after report of an ignition pulse by the ignition pulse recognition means 15, the blocking time functional block 31 switches the control output d to a low level for a defined time, by means of the AND logic means 34. The energy saving means 32 is responsible for ensuring that after an ignition operation of 5 seconds a pause of 25 seconds follows (stand-by operation). The intelligent timer 33 has the function of switching off the output d of the control circuit 12 if the input signal a, i.e. the lamp condition, does not change for a defined time or if there is reported via the input a already several successful ignitions of the lamp, for

example three ignitions. The AND logic means 34 finally links the output signals of the energy saving means 32, of the blocking time functional block 31 and of the intelligent timer and the start counter 33 and generates the control signal d for the controllable switch.

Below, the function of the pulse phase logic means 30 and the energy saving means 32 will be described in more detail with reference to Figures 5a and 5b. The pulse phase logic means 30 requires, along with the oscillator frequency, as further input signals the zero-crossing recognition signal of the zero-crossing recognition means 27 and the information from the 50/60 Hz evaluation means 29, which indicates the mains frequency. These input signals are linked in the pulse phase logic means 30 and evaluated. After determination of a zero-crossing of the mains voltage (point 1 in Figure 5), the pulse phase logic means 30 generates windows in the phase region 60°el - 90°el and 240°el - 270°el of the mains voltage (point 2). Thereby the control of the ignition circuit is made possible only within the phase angles desired by the lamp manufacturers. Before the output signal of the pulse phase logic means 30 reaches the output d of the control circuit 12 it further crosses the energy saving means 32 which has the function of clocking the output signal of the pulse phase logic circuit 30, i.e. allowing the output signal of the pulse phase logic means 30 to pass unhindered for 5 seconds of time, there then following a block of 25 seconds. This on and off switching is necessary in order to maintain small the electrical losses in the ignition circuit. By means of this clocking of the ignition operation a glow discharge at the electrodes of the high pressure discharge lamp - which is damaging for the lamp - can be largely avoided when the lamp has not yet sufficiently cooled for an ignition.

Figure 6 serves for explanation of the AND logic means 34 illustrated in Figure 4 and of the intelligent timer 33.

Figure 6a corresponds to Figure 5a and shows the ignition pulses of one mains half-wave generated with the ignition circuit in accordance with the present invention. Figure 6b shows the output signal of the control circuit 12, which is formed as customer-specific integrated circuit (ASCI, PAL, etc.). The output signal d of the control circuit 12 is made up of the windows of the pulse phase logic means 30 (c.f. Figure 5b) and the so-called blocking time, which is controlled by means of the blocking time functional block 31 shown in Figure 4. The AND logic functional block 34 illustrated in Figure 4 links the output signals of the so-called energy saving means 32 and of the blocking time function block 31. These two signals are necessary for the functioning of the ignition operation. The third input signal of the AND logic means 34 is the output signal of the intelligent timer and start counter 33.

The functions of the blocking time functional block 31 illustrated in Figure 4 and of the intelligent timer 33 will be described in more detail below with reference to Figure 7 and to Figures 8 and 9.

Figure 7a shows an ignition pulse applied to the lamp in a representation with an expanded time axis, Figure 7b shows the output signal d of the AND logic means of the control circuit 12, i.e. the control signal for the controllable switch, likewise in a representation with an expanded time axis. If the output signal d of the AND logic means assumes a high level, the controllable switch is thus switched-on, i.e. closed. At point 1, one recognizes that directly after the switching-on of the controllable switch 10 the voltage at the auxiliary ignition capacitor 11 drops. The energy of the auxiliary ignition capacitor 11 flows via the controllable switch 10 and the charging resistance 13 into the pulse capacitor 7, whereby the latter is charged until the voltage at the pulse capacitor attains a particular switching voltage at point 2. Thereupon, the controllable

switch 9 breaks down and induces a voltage in the pulse transformer 5 whereby a high voltage pulse is induced at the terminal points 2 and 2' of the lamp 4 and a low voltage pulse is induced at the measurement winding 14 (Point 3). The ignition pulse recognition signal detected by the measurement winding 14 reaches the blocking time functional block 31 in the control circuit 12 via the input c. This functional block is thereupon activated and automatically sets the control output d to a low level via the AND logic means 34 (Point 4). During this predetermined blocking time, the oscillation circuit of the pulse capacitor 7, the primary winding 8 and the switch element 9 reliably decays, since the controllable switch 10 is open (Point 5), and the voltage at the auxiliary ignition capacitor again increases. After expiry of the blocking time, the controllable switch is again switched-on (Point 6). Thereafter, the ignition procedure repeats itself at point 7 as already described in relation to point 1. The blocking time is, thereby, always to be selected greater than the time needed for the oscillation circuit to decay.

The function of the intelligent timer will be described below in more detail with reference to Figures 8 and 9. The known circuit shown in Figure 10 applies to the lamp, for the purpose of switching the lamp on after it has been switched off, continuous ignition pulses until the lamp has cooled so far that a renewed ignition is possible. Thereby, although there arises between the electrodes a glow discharge this is however not taken up by the lamp in the hot condition, whereby the lamp is additionally heated through the glow discharge. The reason for this lies in the fact that in the heated condition the gas pressure in the lamp is higher than in the cold condition. As a result of the glow discharge, the electrodes of the lamp are additionally damaged so that the lifetime of the lamp is shortened, if the lamp is to be ignited in hot operation. In order to counter this disadvantage, there have already

been developed timer circuits which for a particular time, for example 11 minutes, apply ignition pulses to the high pressure discharge lamp and switch off the ignition circuit when the lamp is not in operation at the end of this time period, i.e. could not be successfully ignited. If the lamp ignites before the expiry of the 11 minutes, the ignition time used to this point is stored. Should the lamp switch off again, for example for reasons of ageing, the remaining time - up to the predetermined 11 minutes - is employed anew in order to apply ignition pulses to the high pressure gas discharge lamp for a renewed ignition procedure. The overall ignition time of 11 is started with the switching on of the lamp. An interim switching off of the lamp can for example also be caused as a result of a voltage drop of the mains voltage. Even in this case, a new ignition of the lamp should be possible within the 11 minutes overall ignition time. The ageing of the lamp is manifest for example in that the operational voltage increases above the mains voltage, with the consequence that the lamp can no longer be operated and switches itself off. If this case occurs after 11 minutes, the lamp remains permanently switched off. The above-described 11 minutes overall ignition time arose from practical considerations, since such a timer was available in the marketplace. However, overall ignition times adapted also to other timers are likewise conceivable.

The function of the above-described known timer is illustrated in Figures 8a and b and in Figure 9a. Figure 8a shows the triple ignition of a faulty lamp. Dependent upon the cooling of the lamp, a more frequent ignition of the lamp is however also possible. A frequent switching off of the defective lamp is, however, disadvantageous since this can transform into a blinking of the lamp (so-called cycling operation). As a result of the frequent switching on and off, not only does the ballast of the lamp also suffer, but the blinking can be very disturbing in the

lighting of rooms. From Figure 8b it can be seen that after the initial ignition of the lamp in region 1, a remaining ignition time of 10 minutes 55 seconds is present. After the first switching off of the lamp, there follows an ignition operation of 5 minutes, so that after the renewed ignition of the lamp in region 3 a remaining ignition time of only 5 minutes 55 seconds is still available. After the renewed switching off of the lamp, ignition pulses are applied to the lamp for a further 5 minutes until the lamp ignites anew (regions 4 and 5). Thus, there is thereafter only a remaining ignition time of 55 seconds available, which is used up after the renewed switching off of the lamp below region 6, whereby no renewed ignition of the lamp is possible and the timer ends the ignition operation after expiry of the remaining ignition time. Whilst Figure 8 illustrates the function of the timer for an old lamp or in the case of extinguishing the lamp due to so-called mains fluctuations, Figure 9 shows the function of the timer with a missing or defective lamp. Figure 9a thereby shows that with a missing or defective lamp, with the known timer ignition pulses are continuously applied to the lamp, until the expiry of the remaining ignition time, without successful ignition of the lamp.

With this known timer circuit, although an extended cycling operation or a continuous ignition operation can be avoided, ignition pulses are still continuously applied to a lamp which is unwilling to ignite over longer periods of time, so that the disadvantages described with regard to the known circuit shown in Figure 10 are still present. Further, it is disadvantageous that the time measurement is effected, as a rule, by counting the mains half-waves, so that between a 50Hz voltage and a 60Hz voltage there is a difference of 20%. This means, that dependent upon the mains frequency present, different ignition limit times are measured.

It is therefore proposed, in accordance with the invention, to so control the application of ignition pulses by means of the intelligent timer 33 shown in Figure 4 that a lamp in the hot condition is acted upon with ignition pulses for only a relatively short time (for example 5 seconds), then to allow a longer time (for example 25 seconds) to pass before the next ignition packet. In this way, the time until a hot lamp is again capable of ignition is shortened overall and the energy employed for the ignition of the lamp can be significantly reduced. Further, the intelligent timer 33 is so configured that a lamp once switched on should carry out no more than a particular number (for example three) of further switchings-on when in the interim an undesired switching off has occurred. After each switching off, ignition of the lamp is attempted with the above-described ignition packets for a particular time (for example about 22 minutes), whereby the time is independent of the mains frequency. Figure 8c shows the timer control in accordance with the invention, whereby it is apparent that after the third lamp start the ignition circuit is switched off and in ignition operation ignition pulses are applied to the lamp only for 5 seconds. Between the 5 second impulse packets, a 25 second stand-by operation is provided. The timer control illustrated in Figure 8c functions e.g. with an old lamp or a mains interruption.

With the aid of the above-described ignition method, sodium vapour high pressures gas discharge lamps can normally reliably ignited within 4 minutes. Metal vapour high pressure discharge lamps are, in contrast, more difficult to ignite. Thus, there may be provided with the ignition circuit in accordance with the invention, a lamp type dependent changeover with the aid of which a change to a second ignition method, for metal vapour high pressure gas discharge lamps, can be affected, in order to ensure also for this lamp type a reliable ignition. This modified ignition procedure for metal vapour high pressure gas

discharge lamps corresponds in principal to the ignition procedure for sodium vapour high pressure gas discharge lamps, whereby after a certain period of time (e.g. after 4 minutes), however, in which an ignition of the lamp has been unsuccessfully attempted, the ignition time is set to 15 seconds and the blocking time to 75 seconds. Even if a sodium vapour high pressure gas discharge lamp does not initially ignite and thus the changeover to the second ignition procedure for metal vapour high pressure gas discharge lamps occurs, this changeover is not damaging since even then the sodium vapour high pressure discharge lamp is still operated in accordance with the requirements.

Figure 9b shows the timer control in accordance with the invention for the case of a defective or missing lamp. Thereby it is provided in accordance with the invention that the ignition circuit switches off automatically after a clocked ignition operation of 22 minutes. This means that for a lamp start a maximum of 22 minutes ignition operation are available. By means of the lamp start recognition in accordance with the invention, the switching off of the timer circuit in the case of a fault is effected independently of the chosen lamp technology.

As is apparent from the above description, with the ignition procedure in accordance with the invention, the condition of the connected lamp can also be deduced. An aged lamp is operated in accordance with the ignition sequence shown in Figure 8, whilst in the case of a defective or missing lamp the ignition sequence according to Figure 9 appears. It is thus advantageous to provide an additional output at the control circuit in accordance with the invention shown in Figure 4, in particular connected with the intelligent timer 33, at which additional output a signal is made available which indicates the operational condition of the lamp. This signal can for example be delivered to an optical indicator unit (for example a

photodiode) or an acoustic indicator unit (for example a loud speaker). If a photodiode is employed as indicator unit, the photodiode may for example be switched off in the case of a lit lamp and switched on in the case of a defective lamp. The photodiode may flash during the ignition of the ignition apparatus. Equally, the signal can be supplied via a digital or analog interface to a spatially remote control apparatus.

The gains which can be achieved with the above-described first exemplary embodiment in accordance with the invention can for example be seen from Figures 5 and 6. It is apparent that with the ignition circuit in accordance with the invention a very high number of pulses - about 13 ignition pulses - can be generated in the phase range 60°el - 90°el or 240°el - 270°el, which also in each case have the ignition pulse voltage described by lamp manufacturers. By means of an ignition pulse packet with such a high number of ignition pulses there is ensured a very reliable ignition. Since the spacing of the ignition pulses one from another is smaller than 0.3 ms, the pulse width of the individual ignition pulses can be combined to an overall ignition pulse packet, whereby it is apparent from Figures 5 and 6 that the overall ignition pulse width of an ignition pulse packet attainable by means of the ignition apparatus in accordance with the invention is greater than the 2μs prescribed by the lamp manufacturers.

A further advantage of the control circuit 12 in accordance with the invention is the presence of the lamp-alight voltage recognition means 26 shown in Figure 4, which effects a lamp ignition recognition and thus indicates when the lamp has become self-conductive, i.e. when a gas discharge path has been formed in the lamp. After the ignition of the lamp, a voltage drops across the lamp so that the mains voltage is divided into the voltage dropped across the choke 3 and the voltage dropped across the lamp

4, since the pulse transformer is itself of low resistance and can thus be neglected. In the operational condition, a voltage of about 100 V is dropped across the lamp. This voltage is below the breakdown voltage of the sidac 9, so that in the operational condition of the lamp further ignition pulses cannot be generated. By means of the recognition and indication that the lamp is in operation, it is possible to cause the control circuit to permanently open or permanently close the controllable switch 10. The permanent opening or closing of the controllable switch 10 is advantageous for the following reasons.

If the controllable switch 10 is permanently closed, the series circuit of the pulses capacitor 7, the charging resistance 13 and the controllable switch 10 is parallel to the high pressure gas discharge lamp 4. For the operation of a high pressure gas discharge lamp, the lamp manufacturers require that a capacitative load is connected in parallel to the lamp. This can be ensured by means of permanent closing of the controllable switch 10 because of the large capacitance of the ignition capacitor 7, so that the auxiliary ignition capacitor 11 - which is per se provided as capacitative load for the lamp 4 - can be omitted. The circuitry configuration of the ignition circuit can thus be simplified.

On the other hand, if the controllable switch 10 is, after the ignition of the lamp, permanently opened by the control circuit 12, the circuitry part above the controllable switch 10 with the pulse capacitor 7, the primary winding 8 and the switch element 9 will consume no energy during the operation of the lamp and further be subjected to no wear.

In accordance with the invention, the ignition process is in each case interrupted after a pre-defined time. Because of this purposive control of the controllable switch 10,

the high voltage loading is more defined and considered over the overall time is lesser than with the known ignition procedure. Thus, the function of the ballast choke 3 can also be assumed by the pulse transformer 5. The choke 3 can thus be omitted, and the circuitry configuration simplified.

Along with the employment of a single pole switch, in accordance with the invention also the employment of a double pole controllable switch is possible. Figure 2 shows a second exemplary embodiment of the ignition circuit in accordance with the invention, whereby a double pole controllable switch 10 is provided which is switchable between a position (1) and a position (2). In the position (1) the parallel circuit formed on the one hand of the pulse capacitor 7 and on the other hand of the series circuit of the primary winding 8 with the sidac 9 is separated from the a.c. voltage supply present at the input terminals 1 and 1' and is short-circuited, so that via the charging resistance 13 a temporally more rapid discharge of the pulse capacitor 7 is possible, whereby the discharge time of the pulse capacitor 7 is reduced. In the second position (2), the parallel circuit having the pulse capacitor 7 is connected with the a.c. voltage supply, so that charging of the pulse capacitor 7 is possible. The control of the controllable switch 10 with the aid of the control circuit 12 is effected as already described with reference to the first exemplary embodiment in accordance with the invention, whereby the switch position (1) in the second exemplary embodiment corresponds to the opening of the controllable switch in the first embodiment and the switch position (2) in the second exemplary embodiment corresponds to the closed switch position in the first exemplary embodiment. Whilst with the first exemplary embodiment the recovery time of the switch element 9, for example of the sidac, is achieved by means of reliable and rapid decay of the oscillation circuit formed of the pulse

capacitor 7, the primary winding 8 and the switch element 9, with the second exemplary embodiment a reduction of the discharge time of the pulse capacitor 7 is aimed at or attained.

Figure 3 shows a variant of the second exemplary embodiment in accordance with the invention illustrated in Figure 2, whereby solely the position of the charging resistance 13 is altered. The function of the ignition circuit illustrated in Figure 3 corresponds to the function of the ignition circuit shown in Figure 2.

Finally, it is noted that in the case of employment of an ASIC as the control unit 12, the ignition apparatus in accordance with the invention can be combined via a corresponding interface with an ignition time bridging means and a power changeover means obtainable in the marketplace. With ignition time bridging means, a normal incandescent lamp etc. is employed and controlled during the period of time needed by the lamp until it can deliver the nominal light output, in order to ensure a sufficient basic lighting level. Power changeover means ensure, in contrast, on the one hand ignition in accordance with the prescribed requirements and on the other hand a step-wise dimmed lamp operation for energy saving. With regard to the ignition of a lamp it is required by lamp manufacturers to operate a high pressure lamp at 100% power for 330s before dimming the lamp. The ignition apparatus in accordance with the invention can also assume the functions of this ignition time bridging means or power changeover means if the ASIC 15 is correspondingly extended in terms of its circuitry. The ignition apparatus can then be employed as power changeover means or ignition time bridging means depending upon the output side connections.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Ignition circuit for a high pressure gas discharge lamp connectable via corresponding input terminals to an ac voltage source, having a pulse transformer the secondary winding of which is arranged between one of the input terminals and the lamp having a pulse capacitor connected in parallel with the secondary winding and the lamp having a series circuit of a primary winding of the pulse transformer and a switch element connected in parallel to the pulse capacitor, and having a controllable switch connected in series with the parallel circuit of the pulse capacitor on the one had and the primary winding and the switch element on the other hand, wherein the controllable switch is - when an ignition pulse for the lamp is present - temporarily switched for a certain time interval into a first condition in which the parallel circuit is separated from the ac voltage source.

2. Ignition circuit according to claim 1, wherein the secondary winding of the pulse transformer is arranged between a choke coil and the lamp.

3. Ignition circuit according to claim 1 or 2, wherein:

the controllable switch is initially switched into the first condition,

the controllable switch is switched into a second condition, in which the parallel circuit is connected with ac voltage source, when the ac voltage delivered by the ac voltage source is in the phase region 60°el - 90°el of the increasing magnitude, positive or negative, half-wave,

with the presence of an ignition pulse for the lamp the controllable switch is temporarily switched into the first condition for the certain time interval, and

after expiry of the certain time interval the controllable switch is again switched into the second condition.

4. Ignition circuit according to any of the claims 1 to 3, wherein the controllable switch is formed as a single pole switch, which is open in the first condition and closed in the second condition.

5. Ignition circuit according to any of claims 1 to 3, wherein the controllable switch is formed as double pole switch, whereby in the first condition the parallel circuit is separated from the ac voltage source and short-circuited by way of the controllable switch and in the second condition is connected with the ac voltage source by way of the controllable switch.

6. Ignition circuit according to claim 4 or 5, wherein, a charging resistance is connected in series with the parallel circuit and with the controllable switch.

7. Ignition circuit according to claim 4 or 5, wherein a charging resistance is connected between the controllable switch and the ac voltage source.

8. Ignition circuit according to any preceding claim wherein, a protection device, in particular a PTC resistance, is connected in series with the parallel circuit and with the controllable switch, which protection device prevents a thermal overloading of the ignition circuit upon short-circuiting of the switch element or of the controllable switch.

9. Ignition circuit to any preceding claim, wherein a control circuit for control of the switching behaviour of the controllable switch, preferably supplied with the ac voltage delivered from the ac voltage source.

10. Ignition circuit according to claim 9, wherein the control circuit is formed as a customer-specific integrated circuit (ASIC, PAL).

11. Ignition circuit according to claim 10, wherein, the control circuit also fulfils the function of an ignition time bridging means and/or a power changeover means.

12. Ignition circuit according to claim 10, wherein, the control circuit fulfils the function of the ignition time bridging means and of the power changeover means in dependence upon the output side connections of the ignition circuit.

13. Ignition circuit according to any of claims 9 to 12, wherein for temporal control of the controllable switch the control circuit includes a counter.

14. Ignition circuit according to any preceding claim, wherein an ignition pulse recognition device for detecting the generation of an ignition pulse,

15. Ignition circuit according to claim 14 and any of claims 9 to 13, wherein the ignition pulse recognition device is connected with the pulse transformer by way of a winding and indicates the generation of an ignition pulse to the control circuit.

16. Ignition circuit according to any preceding claim, wherein the switch element switches symmetrically with a certain switch voltage.

17. Ignition circuit according to claim 16, wherein the switch element is a symmetrically switching pnpn device, a triac, a sidac, a controlled transistor in a rectifier bridge or a gas spark gap.

18. Ignition circuit according to claim 16 or 17, wherein the certain time interval in which the controllable switch is temporarily switched into the first condition, is selected to be at least so long that a reliable decay of the oscillation circuit formed of the pulse capacitor, the primary winding and the switch element is ensured or a renewed ignition readiness of the switch element is ensured.

19. Ignition circuit according to claim 18, wherein the certain time interval is 40 to 200μs.

20. Ignition circuit according to any preceding claim, wherein a lamp ignition recognition device which monitors the ignition of the lamp and after the ignition of the lamp switches the controllable switch permanently into the first or second condition.

21. Ignition circuit according to claim 20 and any of claims 9 to 13, wherein the lamp ignition recognition device is integrated into the control circuit.

22. Ignition circuit according to any of claims 9 to 13, wherein the control circuit in each case alternately interrupts the operation of the ignition circuit for a first period of time and then resumes the operation for a second shorter period of time.

23. Ignition circuit according to any of claims 9 to 13 or 22, wherein the control circuit deactivates the ignition circuit when the condition of the lamp has not altered for a certain time or the lamp has experienced a certain number of ignitions.

24. Ignition circuit according to any preceding claim, wherein, an auxiliary ignition capacitor is present which is connected in parallel to the pulse capacitor and to the controllable switch.

25. Ignition circuit according to any preceding claim, wherein, the controllable switch is a bipolar transistor, a field effect transistor or a relay.

26. Ignition circuit according to any preceding claim, wherein, the ignition circuit generates a condition signal which indicates the condition of the ignition circuit or the connected lamp.

27. Ignition circuit according to claim 26, wherein the condition signal can be delivered to an indicator unit or to a control device.

28. Ignition circuit for a high pressure gas discharge lamp substantially as hereinbefore described with reference to figures 1-9 of the accompany drawings.

DATED: 24 September, 1998

PHILLIPS ORMONDE & FITZPATRICK

Attorneys for:

TRIDONIC BAUELEMENTE GmbH

ABSTRACT

Ignition circuit for a high pressure gas discharge lamp (4) connected by way of a choke coil (3) to an a.c. voltage source, having a pulse transformer (5) the secondary winding (6) of which is arranged between the choke coil (3) and the lamp (4) and the primary winding (8) of which forms a series circuit with a switch element (9) which series circuit is in turn connected parallel to a pulse capacitor, whereby in series with the parallel circuit of the pulse capacitor (7) on the one hand and the primary winding (8) and the switch element (9) on the other hand, there is connected a controllable switch (10) which is so switched when an ignition pulse for the high pressure gas discharge lamp (4) is present, that a reliable decay of the oscillation circuit formed of the pulse capacitor (7), the primary winding (8) and the switch element (9) is ensured, or a rapid recovery of the switch element (9) is ensured. In this manner, a short ignition pulse series having a high number of ignition pulses can be attained, so that also a reliable ignition of the lamp is ensured.

(Figure 1a)

67411/96

FIG. 1a

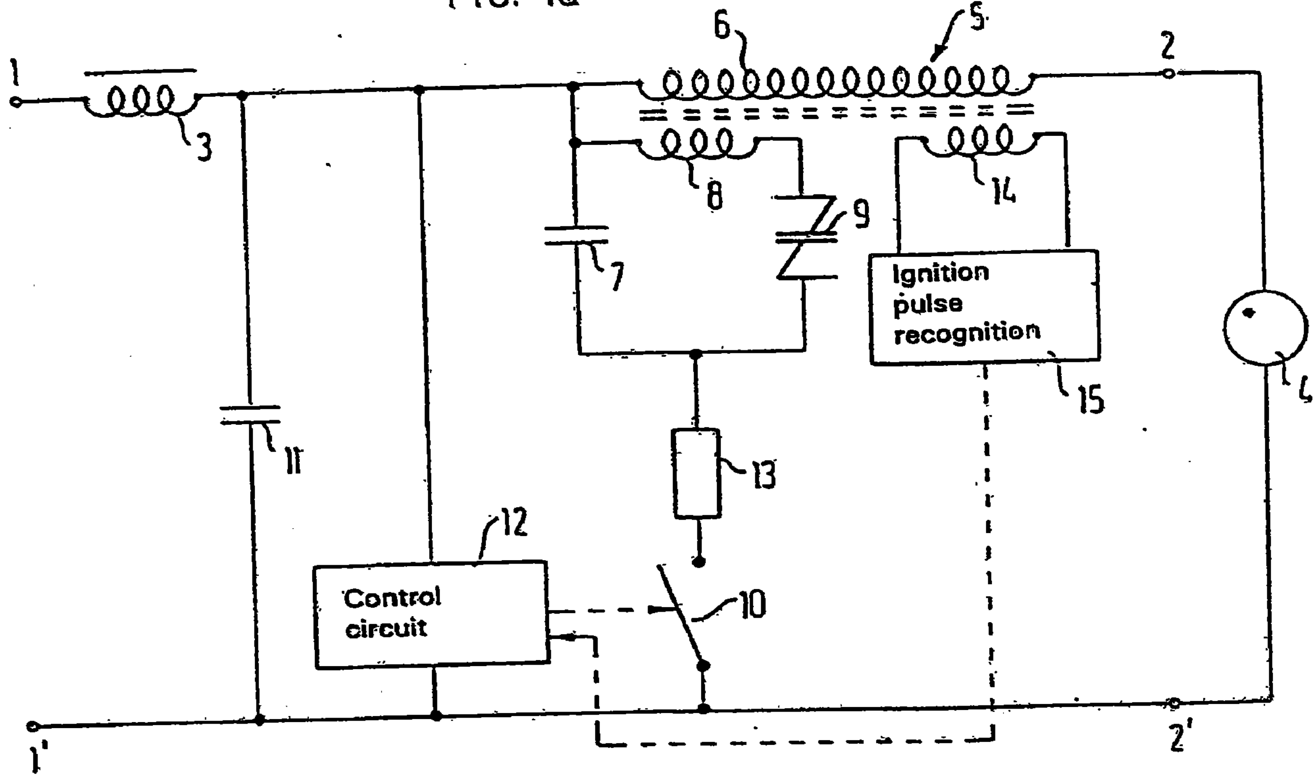


FIG. 1b

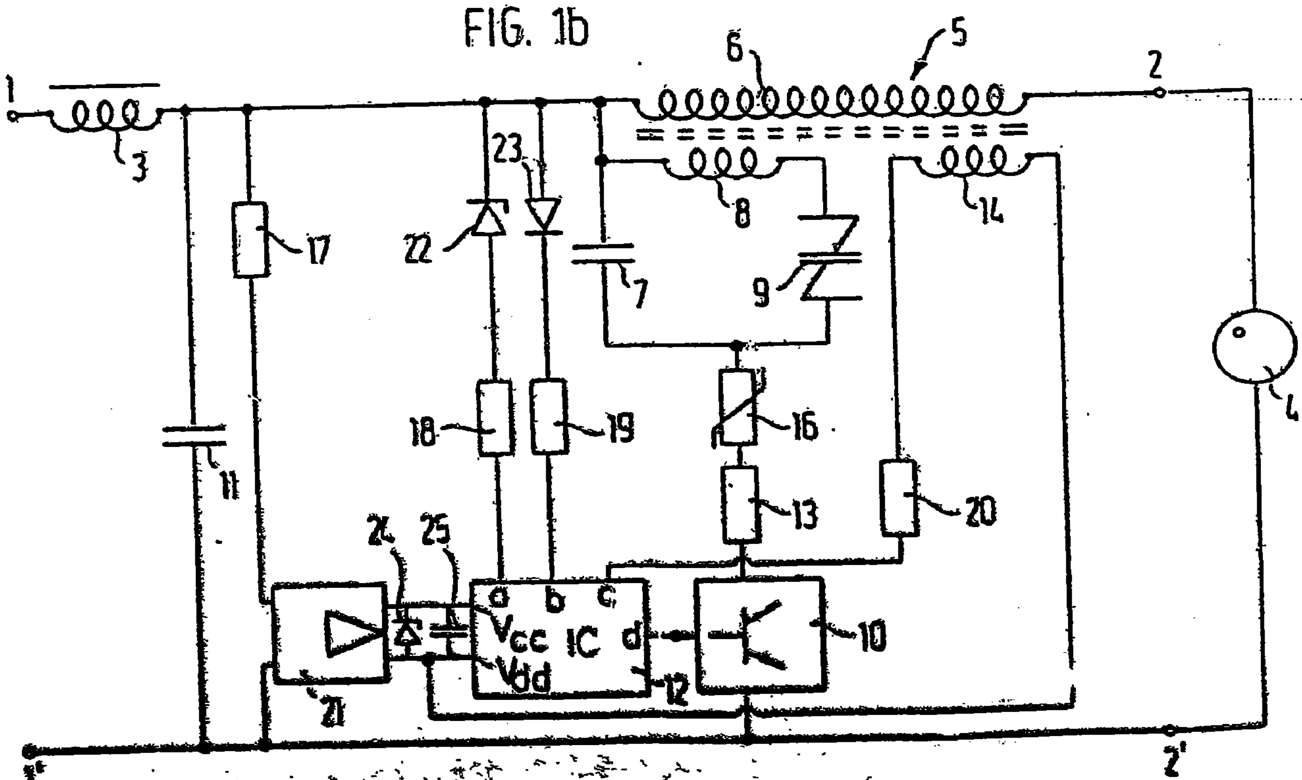


FIG. 2

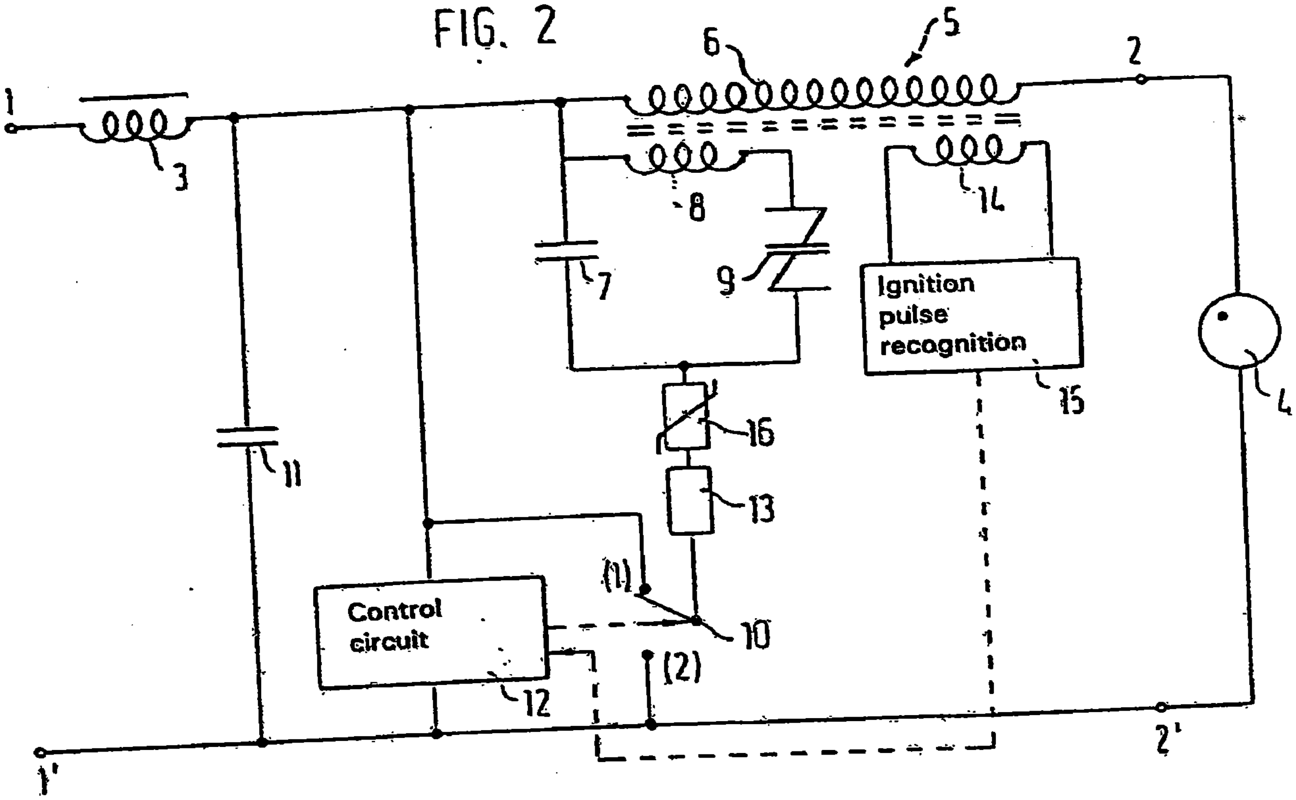

1
3
11
6
5
2
8
7
9
14
Ignition pulse recognition
15
4
16
13
(1)
Control circuit
10
(2)
12
1'
2'

FIG. 3

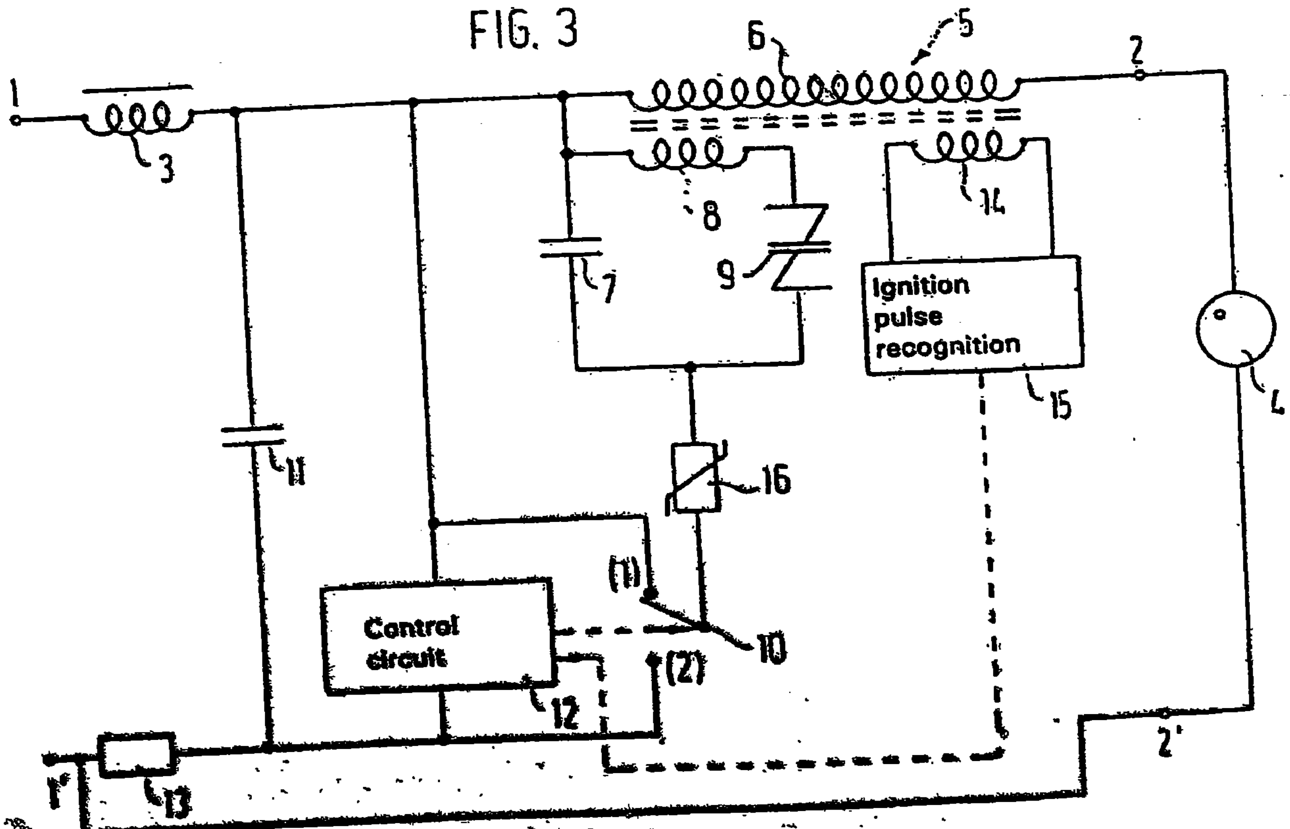

1
3
11
6
5
2
8
7
9
14
Ignition pulse recognition
15
4
16
(1)
Control circuit
10
(2)
12
1'
13
2'

FIG. 4

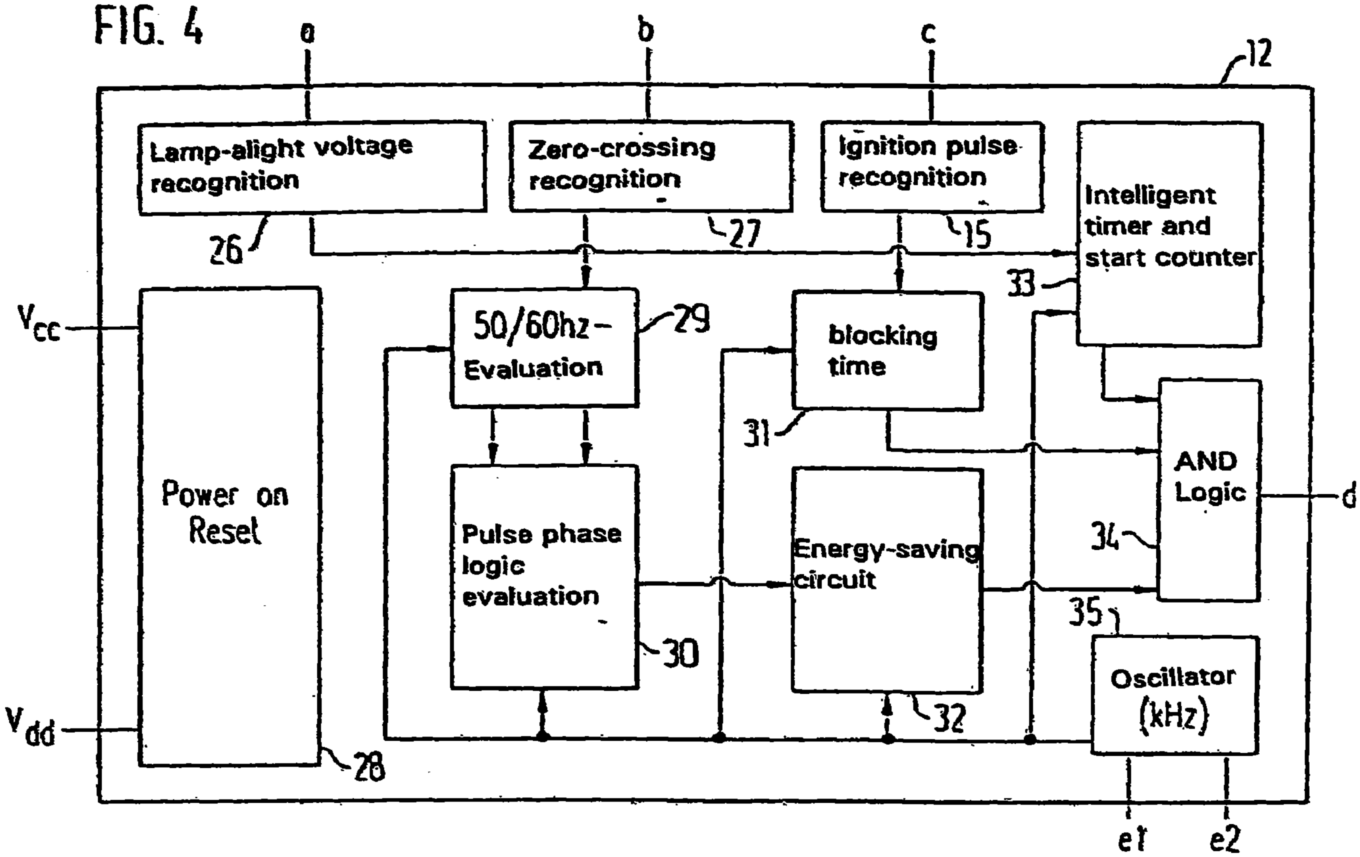

a
b
c
12
Lamp-alight voltage recognition
26
Zero-crossing recognition
27
Ignition pulse recognition
15
Intelligent timer and start counter
33
V_{cc}
Power on Reset
28
V_{dd}
50/60hz-Evaluation
29
blocking time
31
Pulse phase logic evaluation
30
Energy-saving circuit
32
AND Logic
34
d
35
Oscillator (kHz)
e1
e2

FIG. 5

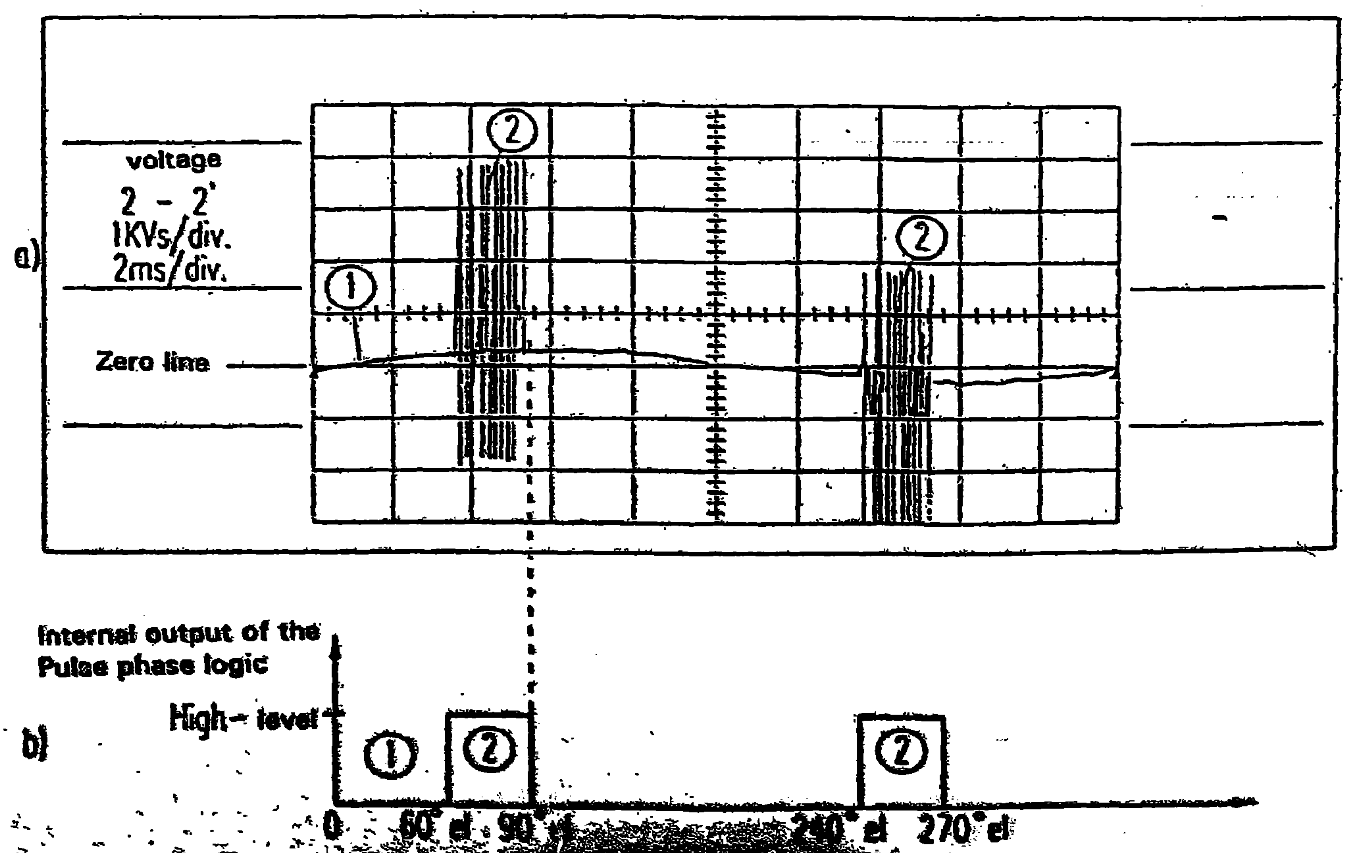

a)
voltage
2 - 2'
1KVs/div.
2ms/div.
Zero line
1
2
b)
Internal output of the Pulse phase logic
High-level
0
60° el
90° el
240° el
270° el

FIG. 6

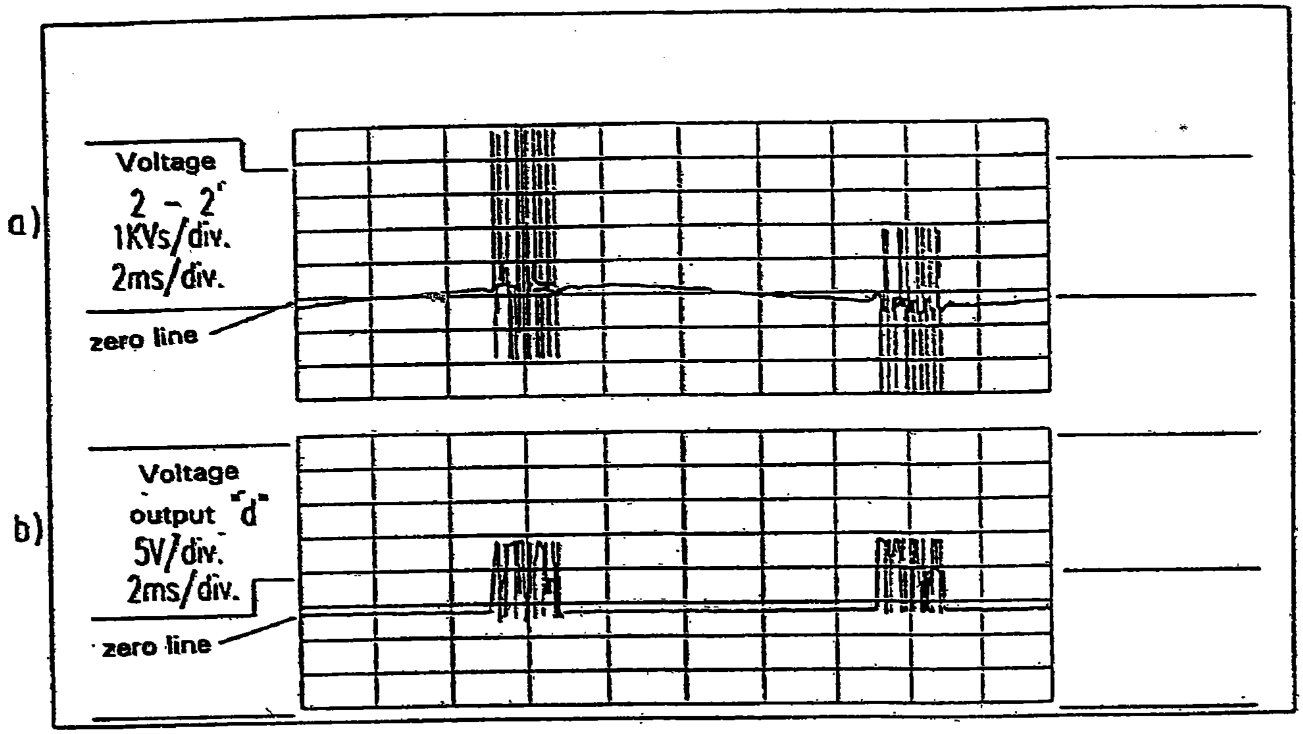

a)
Voltage
2 - 2'
1KVs/div.
2ms/div.
zero line
b)
Voltage
output "d"
5V/div.
2ms/div.
zero line

FIG. 7

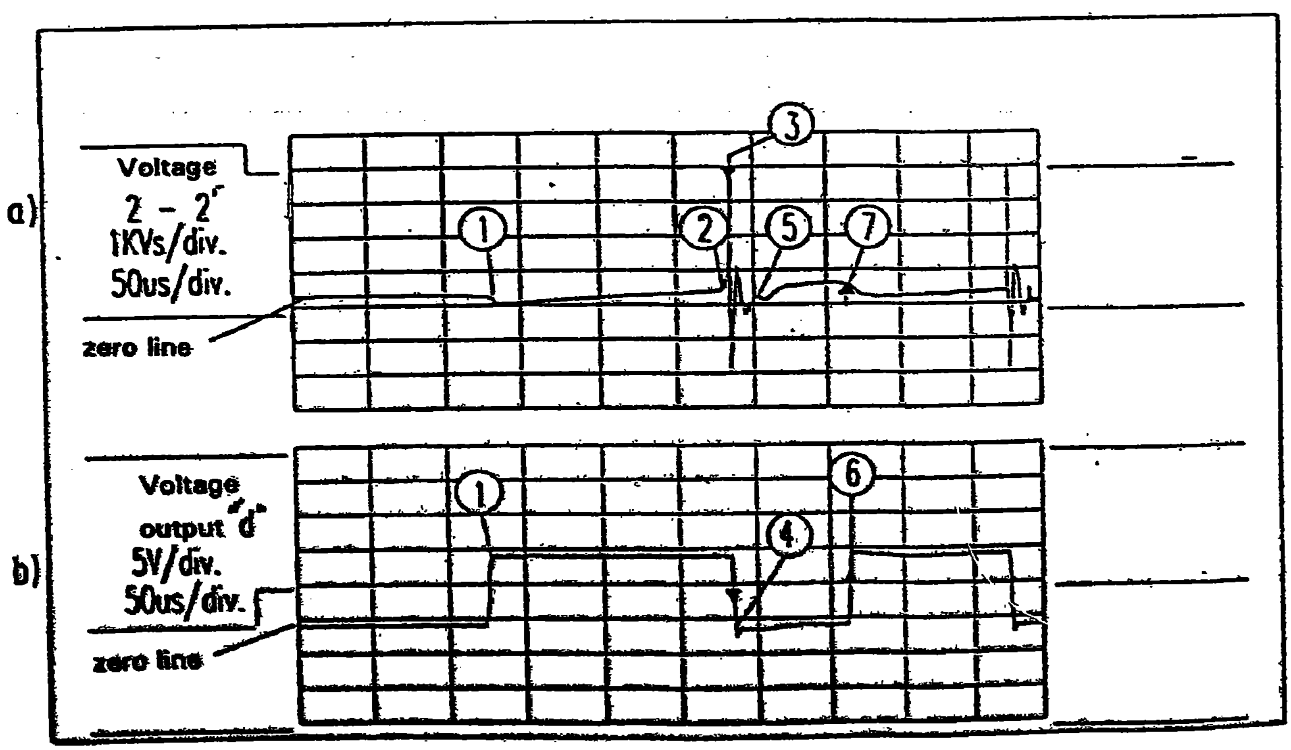
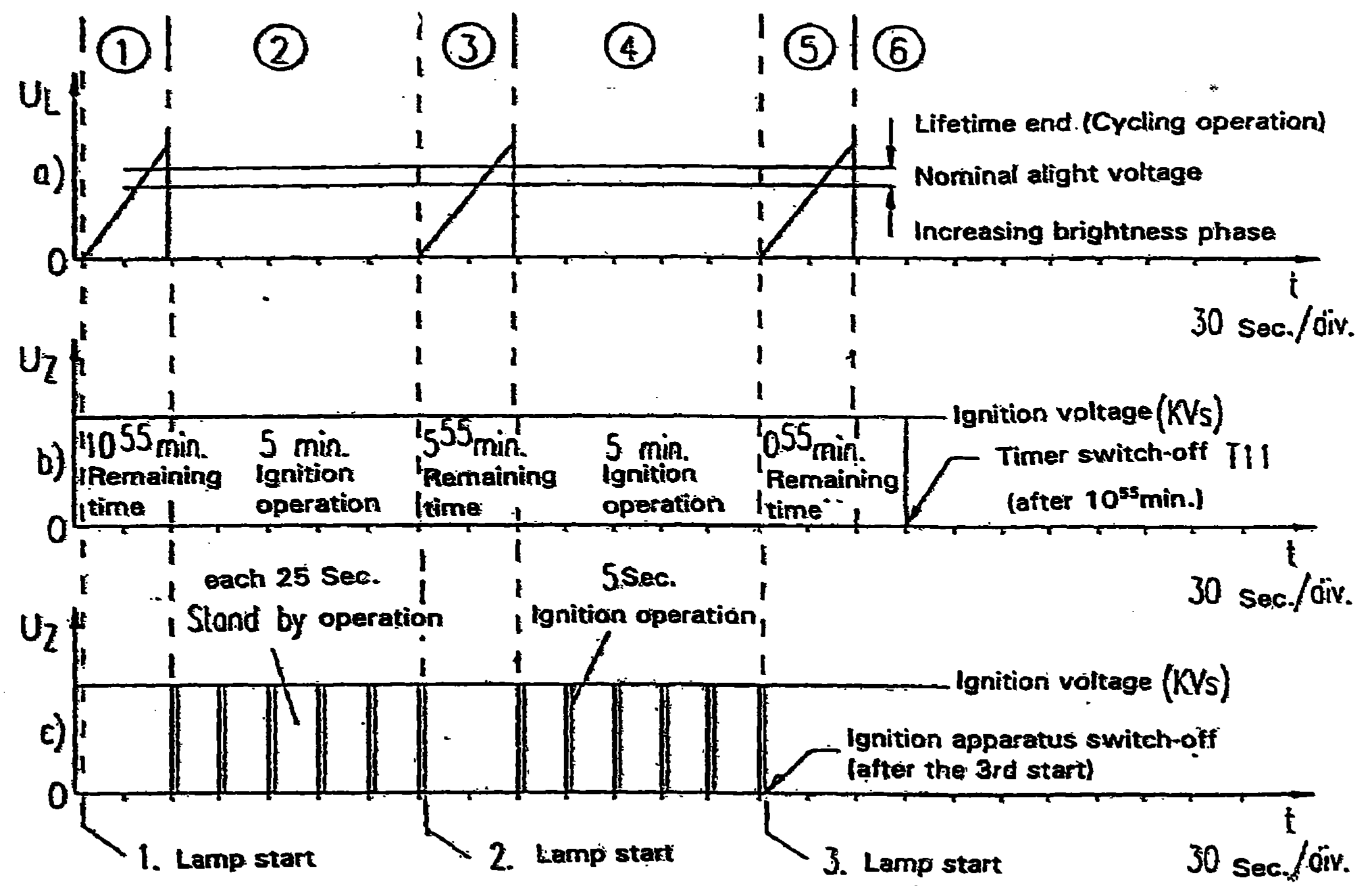
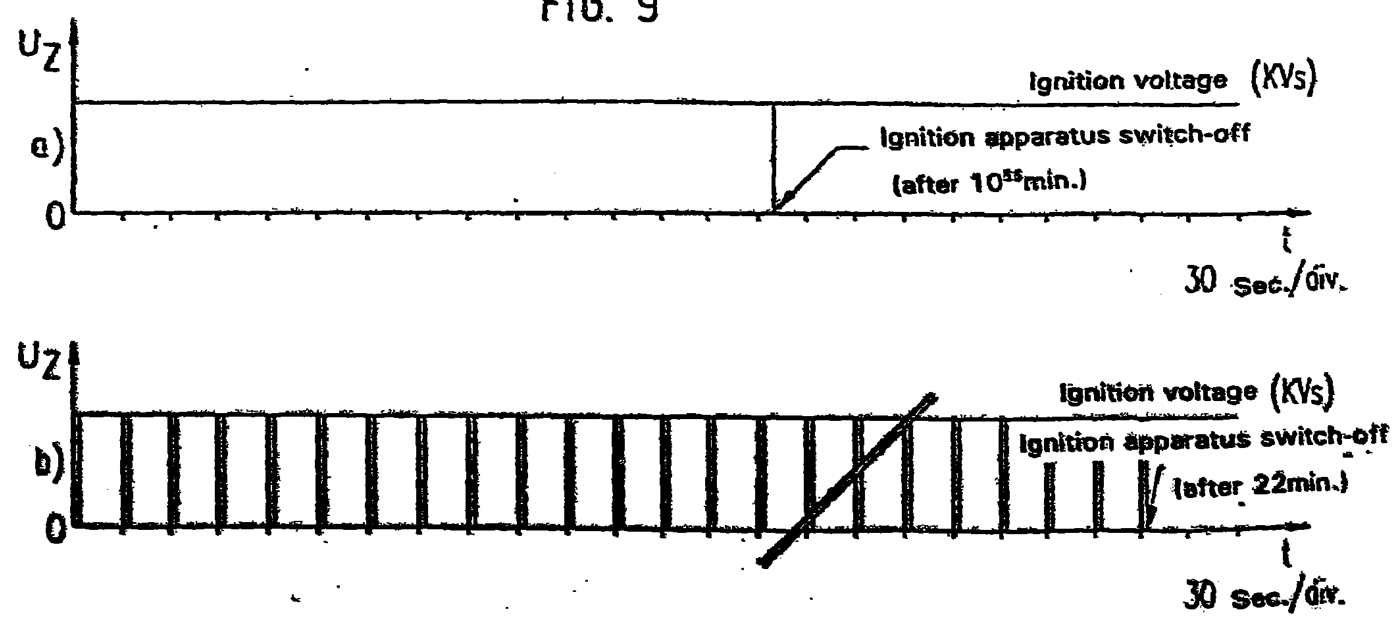

a)
Voltage
2 - 2'
1KVs/div.
50us/div.
zero line
1
2
3
5
7
b)
Voltage
output "d"
5V/div.
50us/div.
zero line
1
4
6

FIG. 8



1
2
3
4
5
6
U_L
a)
0
Lifetime end (Cycling operation)
Nominal alight voltage
Increasing brightness phase
t
30 Sec./div.
U_Z
b)
0
10^{55} min. Remaining time
5 min. Ignition operation
5^{55} min. Remaining time
5 min. Ignition operation
0^{55} min. Remaining time
Ignition voltage (KVs)
Timer switch-off T11
(after 10^{55} min.)
t
30 Sec./div.
each 25 Sec.
Stand by operation
5 Sec.
Ignition operation
U_Z
c)
0
Ignition voltage (KVs)
Ignition apparatus switch-off
(after the 3rd start)
t
1. Lamp start
2. Lamp start
3. Lamp start
30 Sec./div.

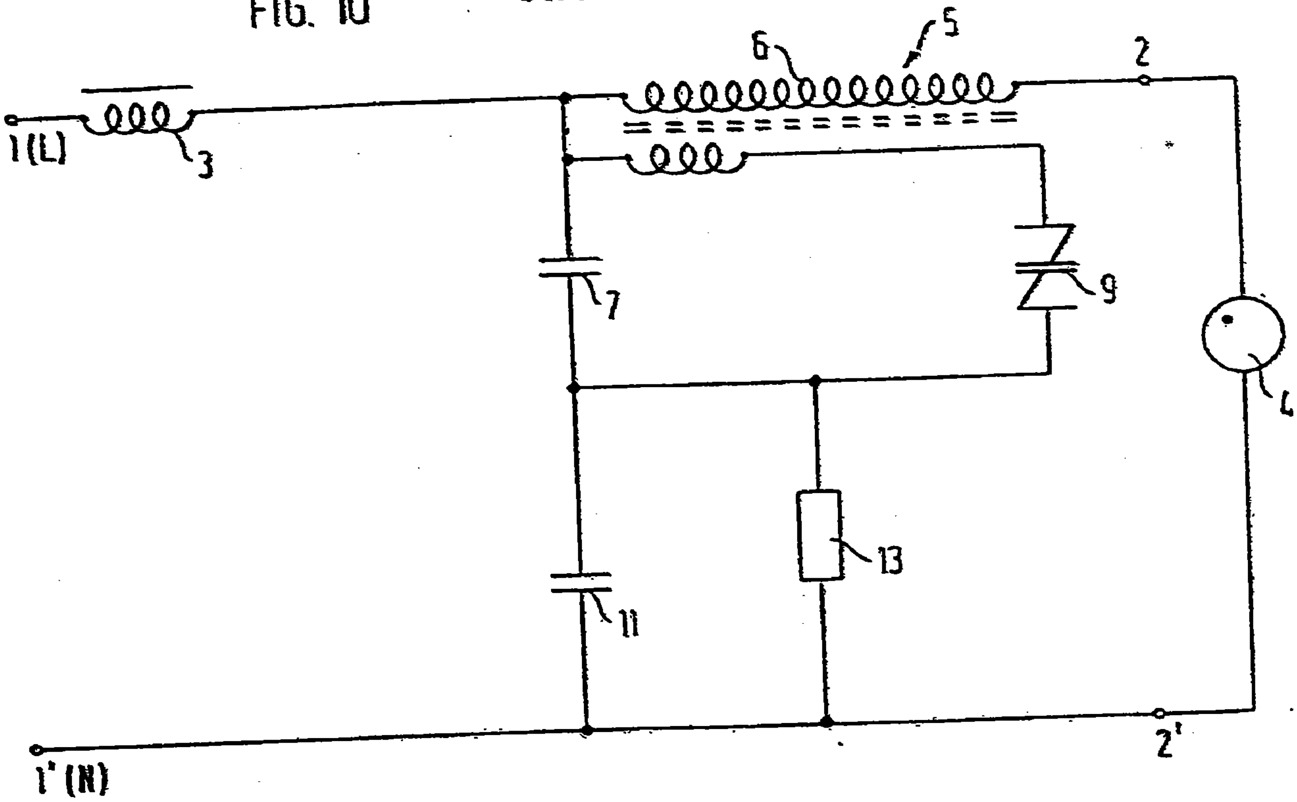
FIG. 9



U_Z
a)
0
Ignition voltage (KVs)
Ignition apparatus switch-off
(after 10^{55} min.)
t
30 Sec./div.
U_Z
b)
0
Ignition voltage (KVs)
Ignition apparatus switch-off
(after 22min.)
t
30 Sec./div.

FIG. 10

State of the Art



INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/03397

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H05B41/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE,A,43 33 884 (HELLA KG HUECK & CO) 6 April 1995 see column 1, line 20 - column 2, line 47; figure 1	1
A	EP,A,0 613 326 (PHILIPS NV) 31 August 1994 see abstract; figure 1	1
A	EP,A,0 479 351 (PHILIPS NV) 8 April 1992 see abstract; figure 1	1
A	EP,A,0 381 083 (ZUMTOBEL AG) 8 August 1990 cited in the application	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
13 November 1996	20.11.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Speiser, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/03397

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A-4333884	06-04-95	NONE		
EP-A-0613326	31-08-94	US-A-	5424617	13-06-95
		CA-A-	2116304	27-08-94
		JP-A-	6290881	18-10-94
EP-A-0479351	08-04-92	DE-D-	69120888	22-08-96
		JP-A-	4245196	01-09-92
		US-A-	5166581	24-11-92
EP-A-0381083	08-08-90	DE-A-	3903149	09-08-90
		AU-A-	4892590	09-08-90

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/EP 96/03397

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 6 H05B41/04

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 6 H05B

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	DE,A,43 33 884 (HELLA KG HUECK & CO) 6.April 1995 siehe Spalte 1, Zeile 20 - Spalte 2, Zeile 47; Abbildung 1	1
A	EP,A,0 613 326 (PHILIPS NV) 31.August 1994 siehe Zusammenfassung; Abbildung 1	1
A	EP,A,0 479 351 (PHILIPS NV) 8.April 1992 siehe Zusammenfassung; Abbildung 1	1
A	EP,A,0 381 083 (ZUMTOBEL AG) 8.August 1990 in der Anmeldung erwähnt	

☐ Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

☒ Siehe Anhang Patentfamilie

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Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Speiser, P

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Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamilie	Datum der Veröffentlichung
DE-A-4333884	06-04-95	KEINE	
EP-A-0613326	31-08-94	US-A- 5424617	13-06-95
		CA-A- 2116304	27-08-94
		JP-A- 6290881	18-10-94
EP-A-0479351	08-04-92	DE-D- 69120888	22-08-96
		JP-A- 4245196	01-09-92
		US-A- 5166581	24-11-92
EP-A-0381083	08-08-90	DE-A- 3903149	09-08-90
		AU-A- 4892590	09-08-90